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The Conundrum of the Workshop OR Etruscan Utilitarian Ceramics: A Compositional Analysis

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The Original Pottery Supply Store

Clay: Elemental for any ceramic workshop

A reconstruction of a roof at Poggio Civitate located in the Museo Civico de Murlo.

•Orientalizing Complex building 2 (OC 2) has been previously identified as a structured used to house the manufacture of varying products, including ceramics.

•If this assessment is correct there would be a need to procure a large amount of raw material such as the *cava* found locally

•In 1986, Tobey, Neilsen, and Rowe subjected a set of ceramic objects from the OC complex to a series of neutron activation analyses (NAA) to analyze their chemical composition and potentially identify the source of the raw material.

•The results of these tests showed that many of the ceramic types were made of the same raw material, but differed in manufacture techniques.

•Their results also indicated that the clay used in coarseware and tile manufacture was not the local *cava.*

•LA-ICP-MS was utilized to measure the chemical make-up of courseware, tile, and a large local clay deposit, the same deposit tested by Tobey, et al., but due to alternative data handling techniques the results differ dramatically.

A Divining Rod for Raw Material Source Determination

Laser Ablation Inductively Coupled Mass Spectrometry (LA-ICP-MS)

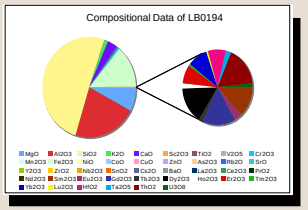
•The use of ICP-MS for ceramic source determination has been proven to be as accurate as neutron activation and the results are comparable as well.

•The GBC Optimass 8000 ICP-MS coupled with a laser ablation sample introduction system allows for precise measurements to be made with damage only occurring to a space of only 2mm by 2mm square space thus minimizing damage to the artifact.

•Once ablated and injected into the Ar plasma, the sample is reduced down to its elemental components whose abundance are measured by atomic mass in a Time-of-Flight mass spectrometer.

•Data is collected for 46 elemental isotopes.

•Using the Gratuze approach, all data are converted to represent each element in its oxide form to better represent the entirety of the clay matrix.



This graph illustrates the abundance of each element oxide in relation to each other. The smaller graph consists of lesser elements found in clays including the rare earth elements.

Understanding the Data

Taking everything into account.

•Elemental composition comparisons of roofing tiles and undecorated utilitarian wares were made from the same raw materials.

•Both ceramic types also have similarly high levels of calcium (Ca) which is derived from an addition of a heat treated limestone ($CaCO_3$) temper.

•The heat treated limestone inclusions appear in pottery throughout the ancient world acting as a bonding agent that prevents cracking during the firing process.

•The reason Tobey *et al.* had difficulties matching the raw material to the ceramic groups is because the limestone temper has leeched enough calcium through the entirety of the clay matrix causing the data to become skewed.

•Steponaitus, Blackman, and Neff (1996) notice this phenomenon in shell-tempered pottery and devised a formula to remove the shell temper, essentially the same matter as limestone ($CaCO_3$), from the clay matrix and make it possible to correctly source the material.

•Tobey *et al.* were able to correctly identify that the same clay was utilized to produce differing ceramic types because no correction formula was necessary. The clay for each ceramic type had the addition of limestone inclusions.

•Although temper was mentioned as a possibility for why Tobey *et al.* could not match the ceramics to the raw source, there was never a follow-up experiment until now.

Where did the raw clay come from?

•Calcium (CaO) is removed from the clay matrix by using the following formula:

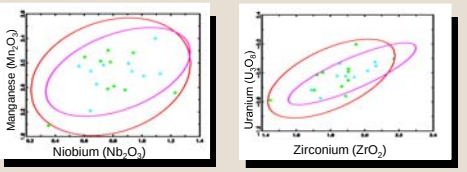
$$e` = (10^6 e)/(10^6 - 2.5c)$$

where $e`$ is the corrected concentration of any element in ppm, e is the measured concentration of any element in ppm, and c is the measured concentration of calcium.

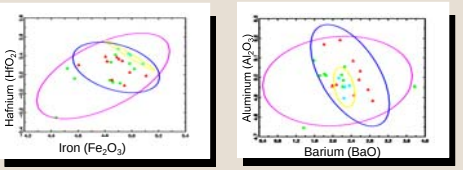
•The resulting data was no longer affected by the leeched calcium deposits.

•The corrected elemental values were compared to the measured values in the raw source material using bivariate scatter plots.

•The resulting data illustrate that the evidence the raw material used in producing utilitarian ceramics and at *Poggio Civitate* was procured from the same local clay mine that had been rejected as a possible source by earlier provenance studies.



No correction formula was needed to distinguish that both the courseware and tile group were manufactured from the same material.



With this new evidence, there is little doubt that the local *cava* is indeed the raw material source used by this site's ancient potters.

A digital reconstruction of the "Workshop" (OC 2) during the Orientalizing period.

Conclusions

•Understanding the process of ceramic manufacturing techniques (*e.g.* tempering) used can be a key issue when looking at chemical data.

•By mathematically extracting aplastic tempering inclusions, it is possible to get a better representation of the original clay composition.

•As suggested by Tobey *et al.*, the dense concentration of the tempering agent caused a misrepresentation of the clay matrix within the ceramic groups and subsequently negating the possibility for the local *cava* as a potential source of raw material.

•With a manufacturing operation of the degree of magnitude as is the case with OC 2 at *Poggio Civitate*, it is necessary to be reminded of Dean Arnold's (1985) notion that "in order for pottery making to originate in a society and develop into a full-time craft, a population must have raw material available in the vicinity of their work area."

• Acknowledgements •

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